Original Article

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Role of Multidetector CT in Blunt Abdominal Trauma

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Abstract

Background: Computed Tomographic (CT) evaluation of Abdomen has become the mainstay of management of all types of trauma to abdomen, in particularly blunt trauma abdomen. This change is mainly attributable to the ability of CT scanning to produce most detailed images of the areas of study or interest. CT can determine the source of hemorrhage. However CT is not that accurate in detecting all types of injuries for example, mesenteric injuries and small bowel injuries are sometimes detected surgically only and missed in CT imaging. **Aims and Objectives:** 1.To study with the aid of multi detector CT (MDCT), different traumatic pathologies of abdomen in blunt trauma. 2. To co-relate imaging findings with surgical findings or clinical data. 3. To evaluate the accuracy of CT in detecting various lesions by statistical analysis. **Subjects and Methods:** The study was conducted in the Department of Radiodiagnosis at A.J Institute of Medical Sciences and Research Center, Mangalore. Patients with history of Road Traffic Accidents, Fall, or assault or other causes where clinically blunt trauma of abdomen is suspected and referred for CT abdomen were studied using Multidetector CT (MDCT) A total of 56 patients with abdominal trauma who underwent Computed Tomography (CT) examination were included. CT findings were compared with surgical findings in 37 operated cases. **Results:** A total number of 56 cases were selected based on Ultrasound and Clinical inferences for CT evaluation. 37 cases underwent surgery and remaining were managed conservatively. On correlating with surgical findings MDCT has a sensitivity of 80% , specificity of 95% for detecting solid organ injury and the PPV and NPV were 97% and 70%respectively. Meanwhile for detection of Hollow Viscus Injury (HVI) sensitivity and specificity were75% and 96% respectively. **Conclusion:** MDCT is the gold standard for evaluation of blunt trauma abdomen. Prompt imaging in proper technique and expertise in reporting improves the detection rate and accuracy of all types of abdominal injuries associated with blunt trauma abdomen. While MDCT diagnosis of solid organ injury is highly accurate, the detection rate of hollow viscus injury and bladder injury is not optimal. Bladder injuries particularly extra-peritoneal type should be further analyzed by ascending urethrogram to confirm it as well as to rule out urethral injury.

Keywords: Computed tomography, Blunt trauma, Abdomen, Injuries.

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Introduction

The economic impact, morbidity and mortality resulting from trauma in general, and blunt abdominal trauma in particular, are substantial. Blunt abdominal trauma makes up 75% of all blunt trauma and is the most common example of this injury.[1] Unlike penetrating abdominal trauma, where management is largely determined clinically, the diagnosis of blunt abdominal injury by clinical examination is unreliable, particularly in patients with a decreased level of consciousness.[2] Confirmation of the presence or absence of injury therefore relies largely on the use of diagnostic adjuncts.

In a large prospective observational study of patients with blunt poly-trauma but no clinical signs of injury found that radiological evidence of abdominal injury was present in almost 10% of patients.[5] Recent consensus guidelines suggest that even in a low threshold of clinical suspicion of blunt trauma abdomen CT evaluation should be ordered without hesitation once we weigh the risks versus benefits of the study.[4- 5]

Accurate imaging facilitates selection for non-operative management, where appropriate, and reduces non-therapeutic laparotomy rates.[3] The main first line investigations are ultrasound, diagnostic peritoneal lavage, and computed tomography.. CT scanning often provides the most detailed images of traumatic pathology and may assist in determination of operative intervention7.Unlike Diagnostic peritoneal lavage (DPL) or focused abdominal sonography for trauma (FAST), CT can determine the source of hemorrhage.[5] Mesenteric injuries and small bowel injuries are sometimes detected surgically only and missed by CT imaging reports.[7] The purpose of this study is to assess the sensitivity as well as specificity of MDCT scan abdomen in detecting injuries by correlating with surgical findings of the same. Ultrasound is the investigation of choice in haemodynamicallyunstable patients. Computed tomography is the investigation of choice in haemodynamically stable patients .Solid organ

injury in haemodynamically stable patients can often be managed without surgery.[8]

Objectives of the study:

1. To study with the aid of Multi-Detector CT, different traumatic pathologies of abdomen in blunt trauma.
2. To evaluate the accuracy of CT in detecting various traumatic pathologies by statistical analysis.
3. To correlate study findings with existing research literature.

Subjects and Methods

The study was conducted in the Department of Radiodiagnosis at AJ Institute of Medical Sciences and Research Center, Mangalore, Karnataka, Mangalore. Patients with history of Road Traffic Accidents, fall, or assault or other causes where clinically blunt trauma of abdomen is suspected and referred for CT abdomen.
All cases underwent FAST scan in the department prior to CTscan.

Inclusion Criteria

1. Clinical suspicion of abdominal trauma.
2. All poly- trauma cases.
3. Hemodynamically stable patients.

Exclusion criteria

All hemodynamically unstable patients were excluded from CT evaluation unless stabilized. Due to large volume of blunt trauma suspected cases in our hospital, Cases with positive FAST ultrasound scan result or with CT findings were selected. Randomization was not required. So a total of 56 patients with abdominal trauma who underwent Computed Tomography (CT) examination were included. All cases underwent FAST ultrasound scan prior to CT. 37 cases out of 56 underwent explorative laparotomy. These cases were evaluated for correlation between radiological and surgical Findings. The remaining cases were evaluated in comparison with clinical outcome and ultrasound correlation.The study was conducted from August 2013 to October 2014.

CT

Out of the 56 cases studied 40 were evaluated using 64 slice Multidetector CT (Lightspeed VCT; GE Medical Systems) and remaining 16 on 128 slice Dual Energy CT (Siemen's; Somatom, Definition). All cases underwent CT evaluation with I.V contrast injection.
The parameters used for acquisition of images in CT abdomen assessment is given below

64 slice MDCT Acquisition Parameters:[9]

Scan mode : Helical
Slice thickness: 5mm

- Pitch: 1.375mm
- Rotation time: 0.5sec
- mA – 300-380mA
- kV= 120kVp

All acquired images were reconstructed into 0.625mm slice thickness using GE factory recon tool inbuilt in scanner. Additional rendering were done for 3D assessment for vascular structures and bones whenever required using ADVANTAGE Workstation tool, GE.

128 slice MDCT (DECT) Acquisition Parameters:

Scan mode: Spiral
Slice thickness: 5mm

- Pitch: 0.6mm
- Rotation time: 0.5sec
- mA = 500 – 625 mA (eff.mAs 200-250)
- kV= 120kVp

All acquired images were reconstructed into 0.7mm slice thickness and additional adjustments like 3D rendering MPR assessment etc. were done using SYNGO.VIA tool of Seimens.

Contrast Media:

Ultravist 370 (iopromide), a low molecular weight Ionic contrast was used for the study at a dose of 1ml/kg body weight dose.

Imaging Protocol

All patients were examined pre and post administration of I.V contrast
A topogramwasacquired prior to scan proper and planner was drawn from above diaphragm to below ischium for a total distance of 512 to 766mm average according to patient's body build. Contrast was administered through a pre-programmed Pressure injector with a flow rate of 3-3.5ml per second and always were followed by 30ml saline push.
Auto imaging technique was used to accurate image acquisition with Region of Interest (ROI) marker kept in sub-diaphragmatic abdominal aorta. Image acquisition times for various phases are as follows
The post contrast study included following phases of image acquisition. After contrast administration
Arterial - 35s
Porto-venous – 45-60s
Delayed- 15 min
Acquired images were analyzed by two Radiologists.Acquired CT raw images were Retro-Reconstructed using aforementioned factory software embedded in the Machine operating system. The sensitivity, specificity, positive predictive value and negative predictive value were calculated for each organ after surgical correlation.

Results & Discussion

A total number of 56 cases were studied, of which 37 cases had undergone surgery. Remaining 19 patients were managed conservatively.
In our Study RTA was seen to be the leading cause of trauma, about 71% of total cases. Majority of cases, about 38% of the affected individuals belonged to the 21- 30 years of age group, followed by 31-40 years (23%).The male to female ratio of our study was 12.5:1, shows that significantly more males were affected than females.
Lone et al,[10] in his study reports the male to female ratio

was 4.4:1

All patients underwent FAST scan prior to the CT evaluation. On comparison with the CT finding FAST scan was found to have a sensitivity of 90% and specificity of 100% for detecting hemoperitoneum.

Table 1: Statistics of hemoperitoneum detected in FAST when compared with CT

Hemoperitoneum In Fast Scan	
Total Positive	45
Total Negative	11
True Negative	6
False Negative	5
True Positive	45
False Positive	0

Nauman Al Quamari et al,[11] found out that the sensitivity and specificity of FAST in detecting intra-abdominal free fluid was calculated to be 91.9% and 94.34% respectively.In another study by Simon Fleminget al.[12] the sensitivity, specificity of FAST scan in detecting hemoperitoneum was 94.7% and 46.2% respectively on comparison with CT findings.

Out of 56 cases A total of 31 (55%) cases Solid organ injury were detected in FAST scan.

Table no. 2 Frequency of injury of solid organ detected in FAST scan

Injury	Number Of Cases	% OF 31
Liver	17	55%
Spleen	13	42 %
Kidneys	8	25 %
Multi Organ Injury	6	19%

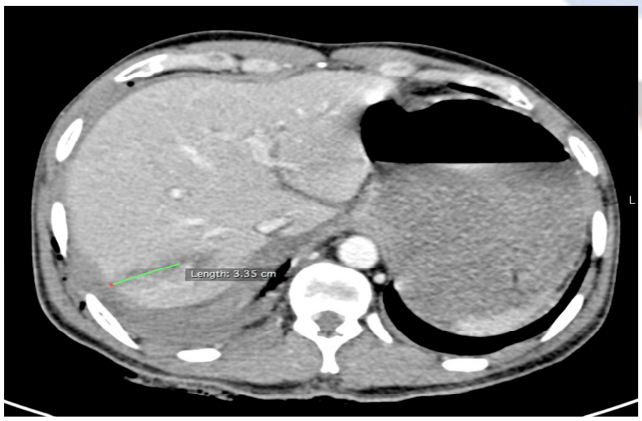


Figure 1: CECT Portal phase study, axial image showing liver laceration with sub capsular hematoma (Grade III)

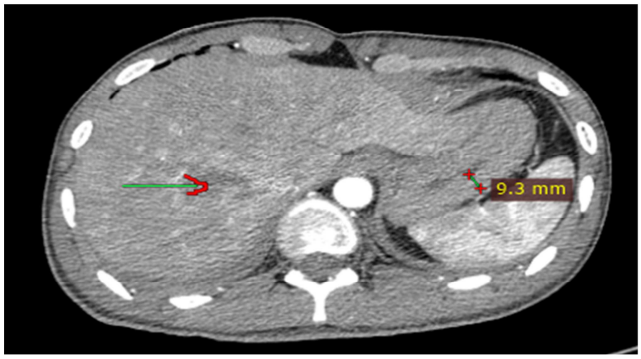


Figure 2: CECT Arterial phase study, axial images showing hematoma in parenchyma (arrow head) Grade II injury.

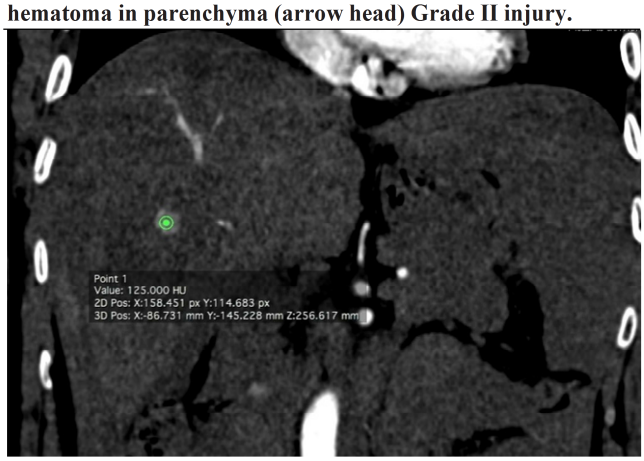


Figure 3: Coronal reformatted CT section showing active contrast extravasation in liver parenchyma (arrow head) in Arterial phase.

Active haemorrhage is identified in early arterial phase in contrast abdomen study as focal high-attenuation areas that represent a collection of extravasated contrast material secondary to arterial bleeding.[17]

In our study39 cases showed positive CT findings of solid organ injury. Liver was the most commonly injured solid organ in 21 cases attributing to 54% of the injured cases followed by Splenic injury in 16 cases attributing to 41% of the injured and renal injuries in 11 cases attributing to 28% of the cases. Grading of injury was done according to AAST criteria. Out of the 39 cases, majority had Grade III and IV injuries (both 30 %), followed by grade II injury (27%).Grade I injuries were seen in 3 cases even lesser than Grade V injuries (4).

Anderson W S et al,[13] studied 68 patients out of which 47 patients underwentcomputed tomography for examination of abdominal injuries. Out of these 47 casesmajority of cases belonged to grade II constituting 45% of cases followed by grade IIIand grade IV with incidence of 21% & 19% respectively. Grade I and grade V wasdiagnosed in 6 and 1 case respectively out of 47 cases with incidence of 13% and 9%each.

Kidney injury scale		
Grade*	Type of injury	Description of injury
I	Contusion	Microscopic or gross hematuria, urologic studies normal
	Hematoma	Subcapsular, nonexpanding without parenchymal laceration
II	Hematoma	Nonexpanding perirenal hematma confirmed to renal retroperitoneum
	Laceration	<1.0 cm parenchymal depth of renal cortex without urinary extravagation
III	Laceration	<1.0 cm parenchymal depth of renal cortex without collecting system rupture or urinary extravagation
IV	Laceration	Parenchymal laceration extending through renal cortex, medulla, and collecting system
	Vascular	Main renal artery or vein injury with contained hemorrhage
V	Laceration	Completely shattered kidney
	Vascular	Avulsion of renal hilum which devascularizes kidney
*Advance one grade for bilateral injuries up to grade III		

Figure 4: Grades of renal injury by Moor et al.[18]

Figure 5: CECT axial section showing Renal injury. Laceration (black arrows), hematoma (white arrows)

Bowel and mesenteric injury were reported in 10 cases attributing to 25% of the total injured cases in our study. CT had a sensitivity, specificity, NPV, PPV of 75%, 96%, 0.90 and 0.88% respectively.

A 2013 study found out that for detecting bowel and mesenteric injury the sensitivity and specificity was 55.33 and 92.06 % respectively. The positive and negative predictive values were 0.61 and .89 % respectively.[14]

We had only two cases of adrenal injury both were diagnosed by CT accurately. Both cases presented as oval shaped hematomas on evaluation.

Figure 6: Adrenal hematoma (Grade V),[18] injury

Adrenal organ injury scale	
Grade*	Description of injury
I	Contusion
II	Laceration involving only cortex (<2 cm)
III	Laceration extending into medulla (≥ 2 cm)
IV	>50% parenchymal destruction
V	Total parenchymal destruction (including massive intraparenchymal hemorrhage) Avulsion from blood supply
*Advance one grade for bilateral lesions up to grade V	

Figure 7: Adrenal gland injury scale by Moor et al.[18]

Table no: 3 Depicts the frequency of various grades of Injury in each organs as detected by MDCT

	Grade Of Injury					Total Number Of Cases	% OF 39
	I	II	III	IV	V		
Liver	3	4	4	9	1	21	54%
Spleen	0	6	6	2	2	16	41 %
Kidneys	0	3	4	3	1	11	28 %
Adrenals	0	1	0	1	0	2	5%
Pancreas	0	0	1	0	0	1	2.5%

Burks DW et al,[15] in their study on 1120 patients followed up for blunt trauma abdomen only 2% were finally diagnosed with adrenal injuries in CT. Nineteen (83%) of theadrenal injuries appeared as discrete round to oval hematomas expanding the adrenal gland

Only one case of pancreatic fracture was reported in our study series. It was grade III on AAST criteria.

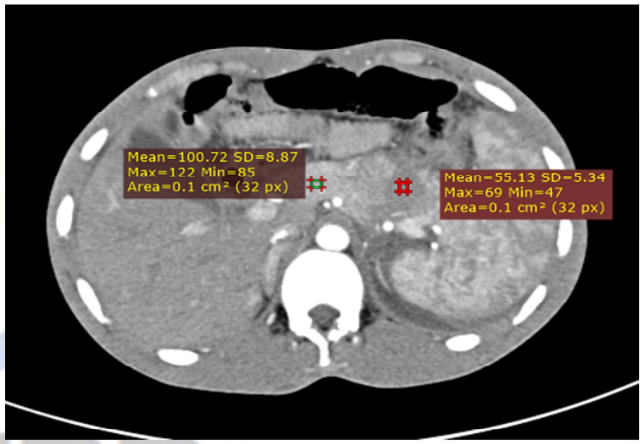


Figure 8: CT Axial scan showing intra-parenchymal hematoma of pancreas.

Akhrass R et al,[16] in their retrospective study on pancreatic trauma analysed 16188 cases of blunt trauma and found out that pancreas was involved in 1.1 per cent of patients with penetrating injuries compared to 0.2 per cent with blunt injuries.

The sensitivity, specificity, PPV and NPV for Bladder injury on comparison with CT findings were 100%, 91.9%, 50% and 100% respectively in our study.

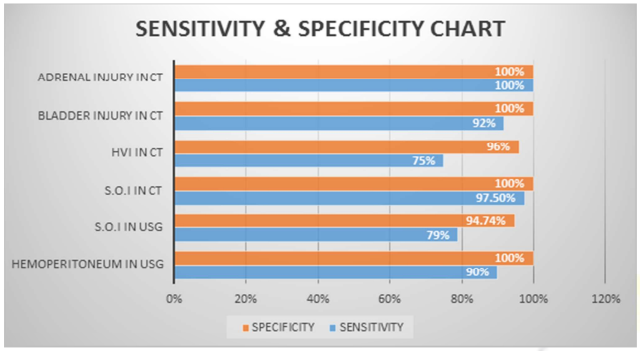
Summary

The detection rate sensitivity and specificity of solid organ injury by CT when compared with surgery were 97.5% and 100% respectively. Meanwhile the PPV and NPV were 100% and 94.74% respectively. For Hollow Viscus Injury, on surgical correlation the sensitivity, specificity, NPV, PPV were 75%, 96%, 90% and 88.9% respectively.

Bladder injuries were analysed separately and we found out the sensitivity, specificity, NPV, PPV of 100%, 91.9%, 50% and 100% respectively on comparison with surgical findings. All false positive cases were suspected to have extra-peritoneal type of bladder injury. On ascending urethrogram evaluation, 3 cases were found to have urethral

injury.

Of the 56 cases admitted during the period of study, 49 cases were discharged on improvement of General condition and follow up done subsequently showed no further complications on any of these patients. 6 pateints died within 48 hours post admission, 2 cases died before intervention and all remaining were post-operative cases. 1 patient was discharged on request by the patient's relatives.One case was diagnosed to have splenic rupture with massive splenomegaly, which was evaluated further for cause of splenomegaly on follow up and was found to have Chronic Myeloid Leukaemia and he is now on Chemotherapy for the same.



Graph 1: Bar diagram comparing sensitivity and specificity. S.O.I –SOLID ORGAN INJURY

Conclusion

MDCT is the golden standard for evaluation of blunt trauma abdomen. Prompt imaging in proper technique and expertise in reporting improves the detection rate and accuracy of all types of abdominal injuries associated with blunt trauma abdomen. While MDCT diagnosis of solid organ injury is highly accurate, the detection rate of Hollow viscus injury and bladder injury is not optimal. In examination where hemo-peritoneum in absence of solid organ injury is found high suspicion of hollow viscus injury should be made. Bladder injuries particularly extra-peritoneal type should be further analyzed by ascending urethrogram in to confirm as well as to rule out urethral injury.

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